ISSN 2449-8955

European Journal of Biological Research

Research Article

DOI: http://dx.doi.org/10.5281/zenodo.4338159

Establishment of plant residues and inorganic fertilizer application for growth and yield of *Vigna unguiculata* (L.) in flood-affected cropland of Koshi Tappu Region, Eastern Nepal

Niroj Paudel[1]*, Samjhana Subedi[2], Tej Narayan Mandal[2], Bishnu Dev Das[3]

[1] Department of Applied Plant Science, Kangwon National University, Chuncheon 24341, Republic of Korea

[2] Department of Botany, Post Graduate Campus (Tribhuvan University), Biratnagar, Nepal

[3] Department of Botany, Mahendra Morang Aadarsha Multiple Campus (Tribhuvan University), Biratnagar, Nepal

* Corresponding author: E-mail: nirojjirauna@gmail.com

Received: 20 October 2020; **Revised submission:** 24 November 2020; **Accepted:** 17 December 2020

http://www.journals.tmkarpinski.com/index.php/ejbr

ABSTRACT: Flood increases due to an increase in river overflow which affects on abiotic and biotic factors. The preliminary study of flood-affected crops was carried out in flood-affected cropland of Koshi Tappu Region of Eastern Nepal. For the experiment the plant residues of *Eichhornia crassipes* and *Sesbania rostrata* and inorganic fertilizer were selected to examine the growth and yield in *Vigna unguiculata*. The appropriate treatments for the production of *V. unguiculata* were analyzed. Before applying treatments, soil was collected and analyzed for physicochemical, microbial biomass and available nitrogen. Soil texture, soil moisture, water holding capacity and bulk density (BD) were calculated. The parameters such as soil pH organic carbon, organic matter and total nitrogen were determined. Soil microbe increases the significance of organic carbon and soil nitrogen is correlated for growth and yield. The results showed that the combined urea and plant residue increases the highest yield. And the *Eichhornia* compost represents the highest leaf area index and biomass. The total pod production was found in the *Echhhornia* compost. The dry weight per single pod in *Eichhornia* fresh was 7.82 g and in *Sesbania* fresh was 7.42 g. It proves that the land pattern is significant for the soil organic compounds. The experiment showed that the use of plant residues enhanced the increase of physicochemical properties of soil by adding the nutrients. The combined Urea + *Eichhornia* supports the best growth and development of the plant.

Keywords: Growth and yield; Inorganic fertilizer; Leaf area index; Plant residue; Soil microbes.

1. INTRODUCTION

Flood is natural disturbance caused due to a sudden increase in the river discharge which is caused by the biotic and abiotic component of the ecosystem which covers fertile land by sediment and sand which decreases the soil fertility and its physical and chemical properties as well. This change in physicochemical properties of soil leads to infertile or barren soil which doesn't support normal growth of vegetation for natural years [1]. Fertile soil has the capacity to supply essential nutrients needed to produce a high yield of nutritious food [2]. The addition of organic matter in flooded soil increases phosphorus fixation with iron and manganese [3]. Organic matter acts as a buffering agent to control the pH of the soil affected by continued chemical N-fertilization and is a good source of micronutrients like manganese, copper, zinc and iron. The most spectacular effect of organic matter in flooded soil is the immediate availability of nitrogen by N_2-fixing bio-fertilizers [4, 5].

The use of the plant residue as source of organic nutrient is relatively simple for the farmers compared to the application of manure [6]. The soil microbial biomass is a liable pool of soil organic matter and comprises 1–3% of the total soil organic matter [7]. Active fraction due to rapid turnover rate and fast release of available nutrients to the plant and thus contributing to nutrient cycling process far greater than its size [8]. The dominating influences of the plant species on soil microbial biomass has been found to be associated with the litter quality and quantity as well as the carbon inputs in the soil. Soil carbon quality and microbial activity vary substantially among the soils treated with different plant material [9]. Soil pH declines the microbial growth under the conditions of acidic or alkaline [10]. The soil microbial biomass carbon and the nitrogen under different amendments and cropping system [11]. The algae and inorganic fertilizer play positive key of the *Coffea arabica* for development and growth of the plant as important manure for the cropping system [12]. The purpose of the research is to assess the effect of plant residues and inorganic fertilizer on soil properties and growth and yield in flood-affected crop soil.

2. MATERIALS AND METHODS

2.1. Selection of site

The study area is located in Koshi Tappu region in between Kushaha west and Haripur village development committee (VDC) in the eastern Tarai region of Nepal. It extends from 26° 31' to 26° 37' N and 87° 00 to 87° 55' E. The Koshi flood has greatly affected the Koshi Tappu Wildlife Reserve and its surrounding agricultural land in the year 2008. Soils are sandy, loamy sand and sandy loam. Before construction of the barrage and the embankments, the Koshi river had spread hundreds of kilometers east and west. The climate of this region is tropical monsoon type. River, oxbow lakes, swamps and marshes were found to be the most important habitats in the Koshi Tappu region, followed by forests, grassland and agricultural land. The vegetation of the Koshi Tappu region is mainly characterized by tropical mixed deciduous riverine forest.

2.2. Experiment design

The experiment was carried out in flood affected cropland in Kushaha west of Koshi Tappu region. Treatments applied in the experiment were as follows: 1) Control (untreated disturbed site); 2) Urea (100%); Urea+ *Eichhornia crassipes* (fresh) – 50:50; 3) *Eichhornia crassipes* (fresh) only 100%; 4) Compost of *Eichhornia crassipes* – 100%; 5) *Sesbania rostrata* (fresh) – 100%.

Treatment was based on nitrogen content applied in the form of urea as per the recommendation of agricultural department. *Eichhornia* fresh, *Eichhornia* compost and *Sesbania* fresh were applied as per equivalent nitrogen content of urea.

Each treatment had three replicates. Test crop was the vegetable yard long bean (*Vigna unguiculata*) grown in the area. The variety was KS-312. It is also commonly called as Chinese long bean or yardlong bean or snake bean.

Each plant was given 23 g N which is equivalent to the 50 g of urea (100%), urea 25g + 277.10 g *Eichhornia* fresh (50%), compost of *Eichhornia* 851.85 g (100 %), *Eichhornia* fresh 554.21 g (100%) and *Sesbania* fresh 671.53g (100%).

Treatment was applied in the soil after 20 days of *Vigna unguiculata* plantation and periodical reading was taken regarding plant growth and production. Compost of *Eichhornia* was made as per the protocol applied in Gausala (the local animal husbandry at Biratnagar). It was made with association of its staffs and the percentage of nitrogen was analyzed in laboratory of Post Graduate Campus, Biratnagar.

2.3. Soil Analysis

Before applying treatments, soil was collected from three pits (10 cm × 10 cm × 15 cm), mixed and pooled as one replicate. It was represented as control soil sample. The collected soil samples were brought to Ecology Research Laboratory of Post Graduate Campus, Biratnagar. Soil samples were divided into two parts. One part of soil samples were air dried and sieved with 2 mm mesh screen for physicochemical analysis. The other part was used for the analysis of soil microbial biomass and available nitrogen.

At the end of experiment, soil samples were collected in triplicate from each treated plot in the same way as mentioned above and packed in air tight polythene bags. The packed soil samples were brought to the laboratory for the further analysis of physicochemical characters, soil microbial biomass and available nitrogen.

2.3.1 Physical analysis of soil

Soil texture was analyzed by sieve method. 50 g of oven dried soil was taken and passed through the series of different sized mesh screen to find the texture of soil. Soil moisture and water holding capacity were calculated. Water holding capacity (WHC) was estimated as follows [13]. Bulk density (BD) was determined by following the [14].

Following are the calculated equation for the physical analysis of soil.

Soil moisture (%) = [(Weight of moist soil – Weight of dry soil) / Weight of dry soil] × 100%

Water holding capacity (%) = [(Weight of saturated soil – Weight of dry soil) / Weight of dry soil] × 100

Bulk density (g/cm) = Weight of oven dry soil / Volume of soil

2.3.2. Chemical analysis of soil

The important parameters such as soil pH [13], organic carbon, [15], organic matter and total nitrogen were determined.

2.3.2.1. Soil pH

It is the degree of acidity and alkanality of the soil. It was measured by pH-meter using a glass-electrode dipped in soil solution (1:5, soil: water) following [13]. Before taking reading the equipment was properly calibrated.

2.3.2.2. Organic carbon

Organic carbon in the soil sample was analyzed by Walkley-Black method (Jakson 1958). 0.5 g of sieved dry soil/ sediment samples was kept into 500 ml conical flask. 10 ml of 1N potassium dichromate ($K_2Cr_2O_7$) and 20 ml conc. H_2SO4 were added and left to stand for 30 min for digestion on asbestos after intermittent swirls. 200 ml of distilled water was added. Now, 5 drops of phenanthrolin redox indicator was added and titrated with 0.5 N ferrous sulphates. If the soil sample is rich in organic carbon, it gives a greenish cast on adding reagent and indicator but if it is not rich in organic carbon, it gives an orange color. Upon titration, an organic carbon rich soil changed from green to light green and finally to maroon red or brown; that was the end point.

Total organic carbon was then calculated as follows:

Organic carbon (%) = [(S – T) × 0.003 × 100 × F] / Weight of soil

where:

S = Volume of potassium dichromate (Volume × Normality)

T = Volume of ferrous sulphate consumed (Volume × Normality)

F = Correction factor (F = 1.33)

2.3.2.3. Organic Matter

Soil organic matter (%) was estimated by multiplying the soil organic carbon (%) with 1.724, as soil organic matter contains 58% organic carbon.

2.3.2.4. Total Nitrogen

Total nitrogen in the soil sample was estimated by micro-Kjeldahl method [15]. The micro-Kjeldahl method consists of the three steps; Digestion, Distillation and Titration.

2.3.2.4.1 Digestion

5 g air dried soil was taken in a dry Kjeldahl digestion flask (300 ml). Then 10 g catalyst mixture (potassium sulphate + copper sulphate + selenium powder in the ratio 10:1:0.1 respectively) was added to the Kjeldahl flask containing soil. To the mixture, 20 ml concentrated sulphuric acid was added with gentle shaking. The flask was placed in fume chamber on heater for digestion. The temperature was raised slowly. Near the end of the digestion process the color was changed from black to brownish and finally greenish. Then the flask was removed immediately and allowed to cool down. After that, 60 ml distilled water was added and filtered. The filtrate was maintained 100 ml final volume by adding distilled water.

2.3.2.4.2. Distillation

During distillation 15 ml digested sample was taken in Kjeldahl flask. Then, 15 ml of 40% sodium hydroxide was added. A conical flask with 5 ml boric acid indicator (2% boric acid + mixed indicator) was placed below the nozzle of condenser in such a way that the end of the nozzle dipped into the indicator solution. The distillate began to condense. The distillation was continued until the volume of distillate in conical flask reached to 15 ml.

2.3.2.4.3. Titration

The distillate was titrated with standard sulphuric acid. The volume consumed by both blank and sample were recorded. The total nitrogen concentration (0.05 N %) was calculated by using this following formula.

Total nitrogen (N) % = [(1.4 (T – B) × N × Dilution factor) / weight of soil sample] × 100

where:

T = Volume of standard acid used in the sample titration

B = Volume of standard acid used in blank titration

N = Normality of standard acid

2.4. Soil microbe biomass

Field moist soil samples were sieved through 2 mm mesh screen and pre conditioned for 7 days at room temperature. Soil samples were spread on the polythene sheets with the moisture content adjusted by 40% water holding capacity. They were then transferred to larger air tight container that held two vials, one containing 20 ml distilled water to maintain 100% relative humidity and the other containing KOH solution to absorb CO_2. The containers were opened for few minutes every day for aeration.

After 7 days, MB-C was determined by chloroform fumigation extraction method [16, 17]. Preconditioned soil samples (25 g) were saturated with purified liquid $CHCl_3$. After 24 hours, it was removed by evacuation and the soil was extracted with 0.5M K_2SO_2 (1:4, soil: extracting) for 30 minutes. This represented the fumigated sample. Another set of unfumigated soil samples were also extracted with 0.5 M K_2SO_4. Biomass C and N were estimated from these fumigated and unfumigated soil extracts.

Soil microbial biomass C (MB-C) was determined in the soil extracts of fumigated and unfumigated samples by dichromate oxidation in a reflux system and titration with ferrous ammonium sulphate.

Biomass C (MB-C) was then estimated from the equation: MB-C = 2.64 EC where EC is the difference between C estimated from fumigated and unfumigated soils, both expressed as µg C/g oven dry soil [16].

2.5 Statistical analysis

All the data were statistically analyzed by using Microsoft Excel and Statistical Package for Social Science (SPSS). Microsoft Excel was used for the data recording, database preparation and descriptive statistic calculation. Value of each sample were analyzed through one way analysis of variance (ANOVA) followed by multiple comparison using Turkey's test and the correlation and regression.

3. RESULTS

3.1 Soil characteristics

The flood affected cropland of Koshi Tappu region was sandy in texture with sand (7.9%), silt (64.5%) and clay (27.5%) (Table1). The water holding capacity was 18.72%. The pH was 6.7. Bulk density, soil moisture and soil porosity was 1.35 g/cm, 10.8% and 49.08% respectively. Soil organic carbon and total nitrogen was 0.28% and 0.04% respectively. Soil organic matter was 0.48%. Soil microbial carbon was 93.87 µg/g.

After application of the different treatments to the disturbed soil, there was change in the physicochemical properties of soil. The change in the soil properties after 80 days of treatments is given in the Table 1.

Table 1. The change in characteristics of soil under different treatments (Mean ± SE).

SN	Properties of soil	Control	Urea	Urea + *E.*	*E.* compost	*E.* fresh	*Sesbania*
1	Texture sand (%) silt (%) clay (%)	 7.9±0.79 64.5±1.86 27.5±1.63	 7.84±0.16 79.76±2.5 12.40±1.6	 11.01±0.9 72.21±0.1 16.87±1.0	 13.41±2.1 72.83±0.4 13.76±1.6	 7.93±11 77.38±1.4 14.65±0.9	 8.87±0.12 76.82±0.2 14.3±0.94
2	Water holding capacity (%)	18.72 ±0.89	33.41 ±2.92	28.01 ±1.0	32.75 ±0.9	30.89 ±0.8	29.43 ±0.9
3	Soil moisture (%)	10.8 ±1.62	12.93 ±0.77	12.74 ±0.26	13.93 ±1.14	12.74 ±0.17	11.70 ±0.07
4	Bulk density (g/cm^3)	1.35 ±0.05	1.30 ±0.01	1.27 ±0.03	1.24 ±0.005	1.27 ±0.005	1.23 ±0.11
5	Soil porosity (%)	49.05 ±2.17	50.94 ±0.70	52.07 ±1.3	53.20 ±0.2	52.07 ±0.2	53.58 ±4.3
6	pH	6.7 ±0.03	7.51 ±2.20	7.72 ±0.08	7.49 ±0.10	7.75 ±0.05	7.66 ±0.005
7	Organic carbon (%)	0.28 ±0.16	0.80 ±0.13	1.05 ±0.02	1.14 ±0.18	0.40 ±0.05	0.50 ±0.1
8	Organic matter (%)	0.48 ±0.27	1.38 ±0.23	1.81 ±0.04	1.97 ±0.32	0.68 ±0.08	0.87 ±0.19
9	Total nitrogen (%)	0.04 ±0.005	0.08 ±0.008	0.10 ±0.003	0.06 ±0.01	0.05 ±0.006	0.06 ±0.005
10	Microbial biomass carbon (µg/g)	93.87 ±9.38	109.51 ±11.5	120.72 ±9.6	103.95 ±3.3	110.35 ±7.6	110.86 ±11.1

In comparison to control, there was no noticeable change in the soil texture. However, water holding capacity increased after treatment. Highest water holding capacity was on urea treatment i.e. 33.41%

followed by *Eichhornia* compost (32.75%). Soil moisture and soil porosity slightly increased in comparison with the Control which was highest in *Eichhornia* compost. The bulk density decreased as the treatment applied in the plants. The highest bulk density was noted on control (1.35 g/cm^3) and lowest on *Sesbania* (1.23 g/cm^3). All the chemical properties of soil such as pH, organic carbon, total nitrogen, organic matter and soil microbial carbon increased in comparison to control.

The pH increased from 6.7 to 7.75 after treatment which was highest on *Eichhornia* fresh treatment. The increased pH percentage of soil was 15.67%. Highest soil organic carbon and soil organic matter was on treatment of *Eichhornia* compost which is 1.14% and 1.97% respectively. Organic carbon in the soil increased more than 4 times the control. Soil organic matter increased from 0.48% (control) to 1.97% (*Eichhornia* compost). Similarly, the total soil nitrogen increased by 150%. The highest total nitrogen was on Urea + *Eichhornia* (0.10%) and lowest on control (0.04%). Application of the treatment played significant role in the increment of the soil microbial carbon. The soil microbial carbon was 93.87 µg/g on control and its value has increased and reached upto 120.72 µg/g in Urea + *Eichhornia.* Urea, *Eichhornia* fresh and *Sesbania* showed almost similar value of soil microbial biomass (109.51 µg/g, 110.35 µg/g and 110.86 µg/g respectively). The soil microbial carbon increased by 28.60%.

Soil organic carbon showed moderately strong, positive and linear association with total soil nitrogen. After treatment soil organic carbon and total nitrogen increased correspondingly (Fig. 1). In general as soil organic carbon increased, its total soil nitrogen also increased.

The Figure 1 and Figure 2 also showed the linear, strong and positive relationship. In Figure 2 as the soil organic carbon increased, the soil microbial carbon also increased. Similarly, after treatment the value of soil nitrogen and soil microbial carbon increased correspondingly.

Figure 1, 2 and 3 showed that the microbial carbon, soil organic carbon and total soil nitrogen were correlated to the each other. Microbial carbon was significantly correlated to the chemical properties of soil, such as organic carbon and total nitrogen.

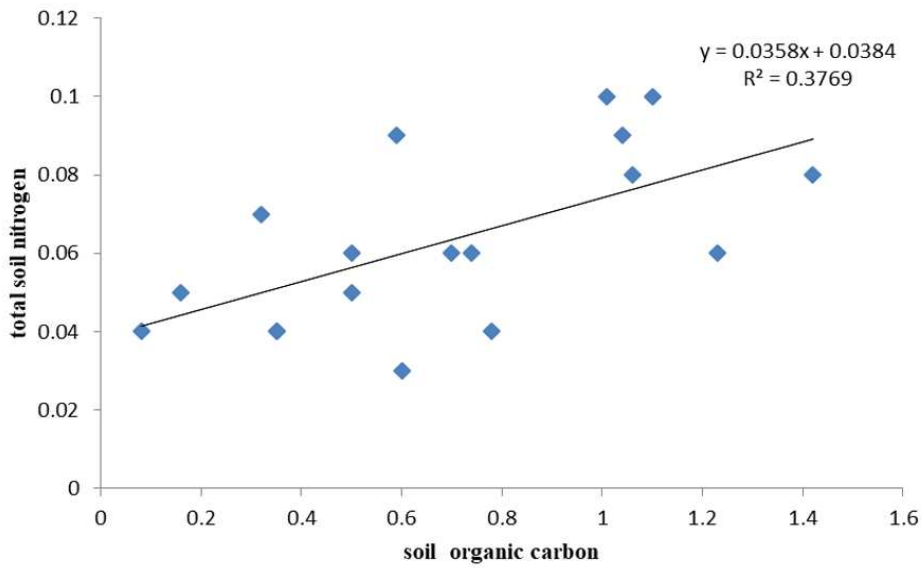

Figure 1. Relationship between total soil nitrogen and organic soil carbon in different treatment.

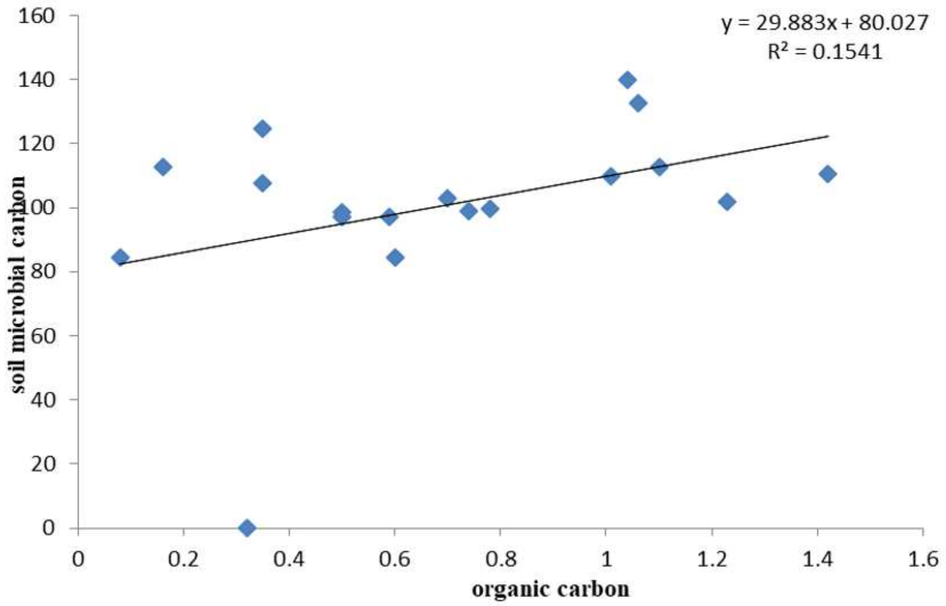

Figure 2. Relationship between soil microbial carbon and soil organic carbon in different treatment.

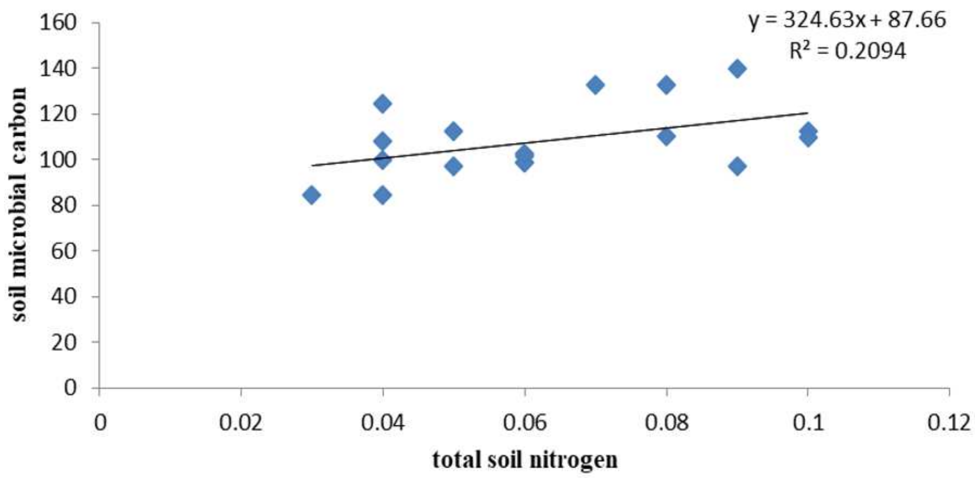

Figure 3. Relationship between soil microbial carbon and total soil nitrogen in different treatment.

3.2 Growth behavior of plants

The Table 2 showed continuous increase in both number of leaf and number of branch in all treatments from 20 days to 80 days except control. In control, the number of leaf and branches increased from 20 days to 40 days and remain almost constant. The combination of urea and *Eichhornia* produced the highest number of leaf (594) and branch (23). The lowest number of leaf and branch was produced in the control *i.e*. 287 and 15 respectively in 80 days.

The value of leaf area index was in increasing order from 20 days to 60 days and then decreased from 60 to 80 days in all the treatments except in control where its value increased from 20 to 40 days and then gradually decreased from 40 to 60 days. The highest leaf area index value was noted on 60 days. *Eichhornia* compost (2.6±0.59) showed highest leaf area index in 60 days followed by Urea + *Eichhornia* fresh (2.5±0.51) and *Sesbania* (2.3±0.49) in Table 3.

In the comparison of height of plant treated with urea and Urea + *Eichhornia* with control, the graph showed there was sharp increase in height of the plant in control in 40 days and remains almost constant from 40 to 80 days. But in the case of urea and Urea + *Eichhornia,* the height of plant increased slowly from 20 days up to 80 days. The height of plant in urea increased from 6.8 cm to 11.3 cm in 80 days where the height of plant in Urea + *Eichhornia* increased from 7.66 cm to 13.06 cm in 80 days (Figure 4).

Table 2. Total number of leaf and total number of branches of plants under different treatments.

Soil treatments		20 days	40 days	60 days	80 days
Control	No of leaf on branch	161	269	284	287
	No of branch	6	13	15	15
Urea	No of leaf on branch	120	233	426	448
	No of branch	5	14	20	21
Urea + *Eichhornia*	No of leaf on branch	90	190	568	594
	No of branch	5	15	20	23
Eichhornia Compost	No of leaf on branch	82	168	312	406
	No of branch	6	14	17	23
Eichhornia Fresh	No of leaf on branch	60	175	210	367
	No of branch	6	11	16	20
Sesbania	No of leaf on branch	95	130	200	360
	No of branch	6	10	18	20

Table 3. Leaf area index of *Vigna unguiculata* in different treatments under different time intervals.

	20 days	40 days	60 days	80 days
Control	1.2±0.03	1.6±0.17	1.2±0.39	1.1±0.36
Urea	1.1±0.19	1.5±0.54	1.9±0.78	1.6±0.57
Urea + *Eichhornia*	1.4±0.2	1.9±0.46	2.5±0.51	2.4±0.31
Eichhornia fresh	1.2±0.34	1.8±0.38	2.2±0.59	1.5±0.40
Eichhornai compost	1.1±0.10	2.0±0.59	2.6±0.12	2.0±0.28
Sesbania	1.1±0.38	1.3±0.29	2.3±0.49	1.5±0.41

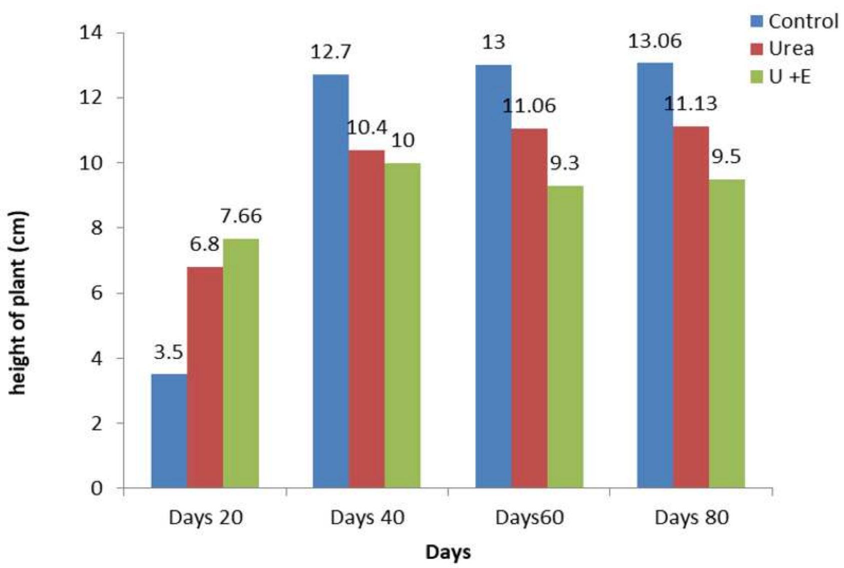

Figure 4. Response in the height of the plant under different treatments (Control, Urea and Urea + *Eichhornia*).

Similarly, the Figure 5 showed the fast increase in the height of plant under control in 40 days and remain constant whereas in other treatment (*Eichhornia* compost, *Eichhornia* fresh and *Sesbania*), the height of plant increased slowly till the end. The slow increase in the height of the plant of *Eichhornia* compost exceeded the height of the control in 60 days and reached maximum 13.7 cm in 80 days. The height of *Eichhornia* fresh reached maximum (11.1 cm) in 60 days. Similarly, the height of plant of *Sesbania* reached maximum (10.4 cm) in 80 days.

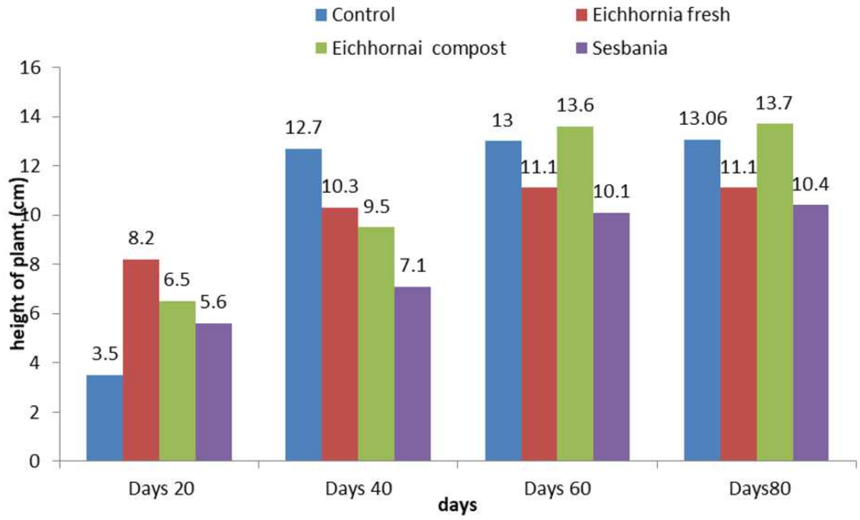

Figure 5. Response in the height of the plant under different treatments (Control, *Eichhornia* fresh, *Eichhornia* compost and *Sesbania*).

3.3 Biomass and yield

The ratio of the fresh weight and dry weight of the harvested plants showed that it was always higher in the belowground plants parts than aboveground except in the case of Urea + *Eichhornia* treatment (Figure 6, Table 2). In aboveground part, highest fresh weight: dry weight was in Urea + *Eichhornia* (4.9). But in belowground part, the ratio was highest in Urea (6.74) (Table 3).

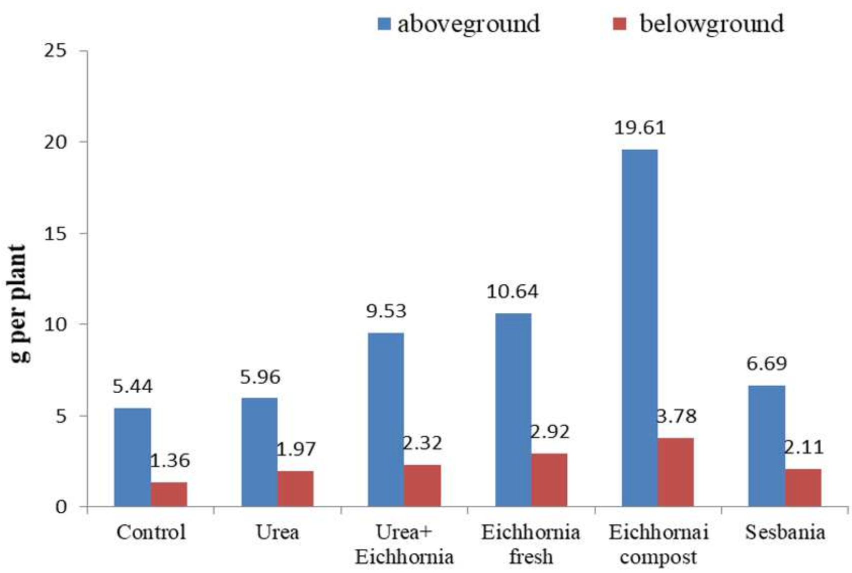

Figure 6. Aboveground and belowground biomass (average dry weight) per plant.

Dry biomass of aboveground part was always higher than the belowground part in all the treatment. Further, aboveground biomass and belowground biomass both were increased due to treatments over control. The graph showed that both the aboveground and belowground biomass was highest in the treatment of *Eichhornia* compost i.e 19.61 g and 3.78 g respectively followed by *Eichhornia* fresh (10.64 g and 2.92 g). The lowest value was reported on control *i.e.* 5.44 g aboveground and 1.36 g belowground.

Table 4. The fresh weight and dry weight ratio of aboveground and belowground part of the harvested plant.

	Treatments (fresh weight : dry weight)					
Plant part	**Control**	**Urea**	**Urea+ *Eichhornia***	***Eichhornia* fresh**	***Eichhornia* compost**	***Sesbania***
Above ground	3.01	4.24	4.9	4.7	3.1	4.65
Below ground	4.7	6.74	4.2	5.6	4.9	4.1

The variation in total pod production was different for treatments in relation to control. The maximum number of pod production was on the plant treated with *Eichhornia* compost *i.e*. 57. The minimum number of pod production was in control, *Sesbania* fresh and urea *i.e.* 28, 30 and 32 respectively. The average dry weight per single pod was highest in urea (8.03 g) and its combination with *Eichhornia* (8.04 g) and *Eichhornia* compost (7.90 g). The lowest dry weight per single pod was in control (5.27 g). The dry weight per single pod in *Eichhornia* fresh was 7.82 g and in *Sesbania fresh* was (7.42 g) (Table 5).

Table 5. Average yield of pods in Yard bean under different treatments in soil.

Soil treatments	Total no of pods	Dry weight of total pods (g)	Dry weight per single pod (g)
Control	28	147.56	5.27
Urea	32	256.96	8.03
Urea + *Eichhornia*	37	297.48	8.04
Eichhornia fresh	40	312.8	7.82
Eichhornia compost	57	450.3	7.90
Sesbania fresh	30	222.6	7.42

4. DISCUSSION

4.1 Changes in soil properties

Soil is a critical part of successful agriculture and the original source of the nutrients that we use for crops. Fertile soil is the most important resource for entire living world. So, soil needs to be systematically and scientifically managed. Before the work was carried out, the soil was average for crop production. The soil had low organic matter (0.48), nitrogen content (0.04) and soil microbial biomass carbon. Application of both plant residues and inorganic fertilizers enhanced the physicochemical characteristics of soil.

Soil microbial biomass has interrelation with physicochemical characteristics of soil [18]. Thus, land use pattern has a significant effect on soil microbial biomass. In the present work, soil organic carbon showed positive correlation with microbial carbon. The value of soil organic carbon and total nitrogen were significantly different in treated soil in comparison to the control. Similarly the value of soil microbial carbon was also significantly different than control. Treatment of soil with *Eichhornia crassipes* and *Sesbania* also showed effective changes in the soil properties due to addition of source of plant residues

[18] that helped for synchronization of demand and supply of plant nutrient during growth and development of *Vigna unguiculata*.

So to improve the soil fertility, different treatments were applied in which the combination of Urea+ *Eichhornia* proved best for soil microbial carbon and total soil nitrogen whereas *Eichhornia* compost was best for organic matter. Hence the work proved that the use of plant residues enhanced the physicochemical properties of soil due to the addition of nutrients.

4.2 Changes in growth and yield

Changes in growth and yield refers to the growth behavior (height of plant, number of branch, number of leaf, leaf area index), changes in biomass and change in yield of pods. Use of organic materials has been suggested to enhance the fertilizer use efficiency. Uses of plant residue as organic nutrient source are relatively simple and effective for the farmers in comparison with the application of manure [6].

In control initially the growth of the plant was rapid but later the growth was retarded due to nutrient limitation. Height of the plant and number of leaf and branch increased fast in the initial stage in control but in other treatments slow increase in initial stage and later the growth was fast and reached the maximum. This happened because in the initial stage, nutrients are immobilized and are not available to the plants. Later when nutrient become released and was available to the plant, growth was faster. Similar observation was also reported by [19]. *Eichhorni*a compost showed the maximum height of plant and leaf area index. For the growth of branch and leaf, the treatment of *Urea + Eichhornia* was best.

In present study, the aboveground biomass and belowground biomass was higher in all the treatments compared to control. *Eichhornia* compost alone had highest aboveground and below ground biomass (19.61 and 3.78 respectively). This increment in plant biomass was 260.47 % in aboveground and 177.94% in belowground. Osoro et al. [20] obtained similar result of increment in crop production using *Eichhornia* compost. The biomass production was more in the treatment of plant residues (*Eichhornia* and *Sesbania*) and its combination with inorganic fertilizer compared Urea alone. The similar result was shown by [21] on growth and yield of cucumber. The positive effect of previous crop residue on productivity by increasing the activities of beneficial soil microorganisms and soil nutrients were studied [22, 23]. Also, the positive correlation was found between the phosphorus concentration of the wheat grain and residue [24].

4.3 Changes in yield of pods

Maximum number of pod production was obtained in *Eichhornia* compost. But the dry weight per single pod was highest in Urea + *Eichhornia* (8.04 g) which was 52.5 % increment over control. Similar result was reported by [25] from the treatment of farmyard manure and inorganic fertilizer. Dry weight per pod was almost near to each other in *Eichhornia* fresh, compost of *Eichhornia* and urea and the percentage increment was about 51%. Percentage increment in yield of pods was 40.79% in *Sesbania.* And, also investigated of additional combination of chemical fertilizer (NPK) was noted best for the *Flemingia macrophylla* [26].

5. CONCLUSION

From experiment that was conducted in flood affected cropland of Koshi Tappu region and above result, it was concluded that:

- Use of plant residues (*Eichhornia* and *Sesbania*) enhances the physicochemical properties of soil.
- Soil organic carbon highest in *Eichhornia* compost and total nitrogen was highest in *Urea + Eichhornia*.

- Soil microbial carbon was increased with organic matter inputs. It was higher in soil treated with Urea + *Eichhornia*.
- Application of Urea + *Eichhornia* increased the dry weight per pod whereas application of *Eichhornia* compost increased number of pod.
- Application of Urea + *Eichhornia, Eichhornia* compost, and *Sesbania* increased the plant biomass than application of urea alone. Highest in *Eichhornia* compost.
- Application of Urea + *Eichhornia* supported the growth of leaf and branch whereas application of *Eichhornia* compost supported the height of plant.

It is concluded that appropriate treatment for better pod production of *Vigna unguiculata* is Urea + *Eichhornia.*

Authors' Contributions: NP and BDD interpreted the results, statistical analysis and wrote the manuscript; SS conduct experiment, collection of data; TNM supervised and design the experiment. All authors read and approved the final manuscript.

Conflict of Interest: The authors declare that there is no conflict of interest.

Acknowledgement: The author's are thamkful for Department of Botany, Post Graduate Campus, Biratnagar, Nepal for the laboratory facility. Also, thanks for the reviewer who make the valuable suggestion for the improvement of manuscript.

REFERENCES

1. Sumithra S, Ankalaiah C, Rao D, Yamuna RT. A case study on physiochemical characteristics of soil around industrial and agricultural area of yerraguntla, Kadapa district, A.P, India. Int J Geo Earth Environ Sci. 2013; 3(2): 29-34.
2. Alley MM, Vanlauwe B. The role of fertilizer in integrated plant nutrient management IFA, Paris, France. 2009.
3. Hesse PK. Potential of organic materials for soil improvement. In: Organic matter andrice. International Rice Research Institute, Manila. 1984; 35-56.
4. Singh PK Biofertilization of rice crop. In: Sen SP and Palit P, eds. Biofertilizers: potentialities and problems. Plant Physiol Forum, Calcutta. 1988; 104-114.
5. Singh PK, Bisoyi RN. Blue green algae in rice fields. Phykos. 1989; 28: 181-195.
6. Abbasi MK, Tahir MM, Sabir N, Khurshid M. Impact of the addition of different plant residue on nitrogen mineralization-immobilization turnover and carbon content of a soil incubated under laboratory conditions. Solid Earth. 2015; 6: 195-205.
7. Jenkinson DS, Ladd JN. Microbial biomass in soil: measurement and turnover. In: Pau EA, Ladd JN, eds. Soil Biochemistry, Vol. 5. Marcel Dekkar, New York. 1981; 415-471.
8. Walley FL, VanKessel C, Pennock DJ. Landscape - scale variability of N-mineralization in forest soils. Soil Biol Biochem. 1996; 28: 383-391.
9. Chu H, Grogan P. Soil microbial biomass, nutrient availability and nitrogen mineralization potential among vegetation-type in a low arctic tundra landscape. Plant Soil. 2010; 329: 411-420.
10. Dalal RC, Mayer RJ. Long-term trends in fertility of soil under continuous cultivation and cereal cropping in Southern Queensland. VII Dynamics of nitrogen mineralization potential and microbial biomass. Aust J Soil Res. 1987; 25: 461-472.

11. Logah V, Safa EY, Quan C, Danso I. Soil microbial biomass carbon, nitrogen and phosphorus dynamic under different amendments and cropping system in the semi-deciduous forest zone of Ghana. West Afr J Appl Ecol. 2010; 17: 121-133.
12. Paudel N, Kang WH. Establishment of algae as bio-fertilizer for coffee plant. Int J Sci Rep. 2018; 4(6): 153-157.
13. Piper CS. Soiland plant analysis. Hans publisher, Bombay. 1966.
14. Brady NC. The nature and properties of soil. Macmillan Publishing Company New York. 1984.
15. Jackson ML. Soil Chemical Analysis. Prentice Hall, Englewood Cliffs, New Jersey. In: Pau EA, Ladd JN, eds. Soil Biochemistry, Vol. 5. Marcel Dekkar, New York. 1958; 415-471.
16. Vance ED, Brookes PC, Jenkinsion DS. An extraction method for measuring soil microbial biomass carbon. Soil Biol Biochem. 1987; 19: 703-707.
17. Brookes PC, Landman A, Pruden G, Jenkinson DS. Chloroform fumigation and the release of soil nitrogen: a rapid direct extraction method to measure microbial biomass nitrogen in soil. Soil Biol Biochem. 1985; 17: 837-842.
18. Kara O, Bolat L. The impact of different land uses on soil microbial biomass carbon and nitrogen in Bartin Province. Soil Sci Ecol. 2007; 32: 281-288.
19. Oli PS. Effect of litter treatment on soil microbial biomass and plant growth, Master dissertation. Post Graduate Campus, Biratnagar, Tribhuvan University, Nepal. 2015.
20. Osoro N, Muoma JO, Amoding A, Mukaminega D, Muthini M, Ombosi O, Maingi M. Effects of water hyacinth (*Eichhornia crassipes* Mart. solms) compost on growth and yield parameters of maize (*Zea mays*). Brit J Appl Sci Tech. 2014; 44: 617-633.
21. Eifediyi EK, Ramison SV. Growth and yield of cucumber (*Cucumis sativs* L.) as influenced by farmyard manure and inorganic fertilizer. J Plant Breed Crop Sci. 2010; 2: 216-220.
22. Urra J, Mijangos I, Lanzén A, Lloveras J, Garbisu C. Effects of corn stover management on soil quality. Eur J Soil Biol. 2018; 88: 57-64.
23. Zhang Li WJ, Fu G, Zhao Y. Rotary tillage in rotation with plowing tillage improves soil properties and crop yield in a wheat maize cropping system. PLoS One. 2018; 13(6): e0198193.
24. Hirzel J, Undurraga P, Leon L, Panichini M, Carrasco J, Gonzalez J, Matus I. Different residues affect wheat nutritional composition. J Soil Sci Plant Nutr. 2020; 20: 75-82.
25. Satyanarayan V, Prasad PV, Murthy VRK, Boote KJ. Influence of integrated use of farmyard manure and inorganic fertilizers on yield and yield components of irrigated lowland rice. J Plant Nut. 2002; 25(10): 2081-2090.
26. Kumar A, Rani M. Lac, *Kerria lacca* rearing on *Flemingia macrophylla* with NPK fertilizer: impact on plant growth, lac yield, and lac parasitisation. Eur J Biol Res. 2019; 9(4): 259-266.